

Amendment of September 30, 2004

AMENDMENTS TO THE SPECIFICATION

Page 1, Line 3, delete this paragraph, namely "Description"

Page 1, Line 3, before this line insert the following paragraph heading:

FIELD AND BACKGROUND OF THE INVENTION

Page 2, please replace the paragraph beginning at line 14 with the following rewritten paragraph and one paragraph heading:

SUMMARY OF THE INVENTION

A hydraulic control arrangement ~~according to the preamble of patent claim 1~~ is known, for example, from DE 197 15 021 A1. This is a hydraulic control arrangement according to the load-sensing principle, in which a variable displacement pump or a bypass pressure compensator assigned to a fixed displacement pump is set, as a function of a control pressure changing with the highest load pressure of the actuated hydraulic consumers, preferably as a function of the load pressure itself, in each case in such a way that the pump pressure lies above the highest load pressure by the amount of a defined pressure difference, the regulating Δp . For this purpose, the control pressure is supplied via a load indication line to a load-sensing regulating valve which is implemented by a regulating valve of the variable displacement pump or by the bypass pressure compensator. Said load indication line is composed of a number of line segments

corresponding to the number of directional control valves. Each directional control valve has an individual indication duct. Changeover valves serve for connecting the individual indication duct carrying the highest pressure to the load indication line and the line segments of the latter to one another.

Page 4, please replace the two consecutive paragraphs beginning at line 14 with the following two consecutive rewritten paragraphs:

~~The aim on which the invention is based is~~ It is an object of the present invention to develop a hydraulic control arrangement which has the above-identified features ~~from the preamble of patent claim 1~~, in such a way that the load pressure for one hydraulic consumer is limited in a cost-effective way to a lower value than for another hydraulic consumer, specifically is limited to the lower value, irrespective of whether the second function is actuated alone or together with the first function. The second function is consequently to be reliably protected from too high a pressure.

The sought-after aim is achieved, according to the invention in that, in the hydraulic control arrangement having the features of the invention ~~from the preamble of patent claim 1~~, the pilot valve arrangement can be set from a high first limit pressure to a lower second limit pressure in the case of a defined pressure occurring in a further line segment of the load indication line, and in that, as seen from the first line segment of the load indication line, the individual indication ducts can be connected to the successive line segments of the load indication line according to falling maximum load pressure of the hydraulic consumers. A control arrangement according to the invention serves for the actuation of two or more groups of one or more

hydraulic consumers in each case, the groups differing from one another in different maximum load pressures. As seen from the regulating valve, therefore, the load indication line has located in it, first, the line segments which can be connected via a changeover valve to an individual indication duct to the directional control valve by means of which a hydraulic consumer from the group having the highest maximum load pressure can be controlled. These are then followed by the line segments for the group of hydraulic consumers having the second highest maximum load pressure, then the line segments for the group having the third highest load pressure, and so on and so forth. Conventionally, for reasons of simple bore drilling and having as identical a configuration of the individual directional control valve sections as possible, the sequence in a valve block will also correspond to this sequence, so that, in said valve block, the directional control valve sections for the group of consumers having the highest maximum load pressure are followed by the directional control valve sections for the group having the second highest maximum load pressure. If more than two different maximum load pressures are provided, the directional control valve sections for the group having the third highest maximum load pressure then follow. Then, overall, the directional control valve sections are arranged in the valve block according to falling maximum load pressure. When a hydraulic consumer from a group not having the highest maximum load pressure is actuated, the corresponding line segment of the load indication line is acted upon with the load pressure via the assigned changeover valve. By means of this pressure, the pilot valve arrangement is controlled in such a way that the pressure in the first line segment of the load indication line between the nozzle and the regulating valve cannot overshoot the maximum control pressure corresponding to the lower maximum load pressure, at least when the lower maximum load pressure is reached at the corresponding

consumer. If the group comprises a plurality of hydraulic consumers and consequently a plurality of directional control valves and a plurality of line segments of the load indication line, the pressure tap in the foremost line segment, that is to say in that line segment of these line segments which is nearest to the regulating valve, is sufficient, since the pressure passes from line segments located further to the rear into the foremost line segment via one or more changeover valves. In the case of a hydraulic control arrangement according to the invention, no individual pressure compensators are necessary in order to have different maximum load pressures for the hydraulic consumers.

Page 7, please replace the eleven consecutive paragraphs beginning at line 9 with the following eleven consecutive rewritten paragraphs and paragraph heading:

In principle, it is conceivable to detect the pressure in a further line segment of the load indication line by means of a pressure sensor and to adjust the pilot valve arrangement electrically. In terms of outlay, however, it seems simpler ~~if, according to patent claim 2, wherein~~ the pilot valve arrangement can be adjusted hydraulically via a control line which is connected to the further line segment of the load indication line.

In terms of space requirement, it seems especially advantageous if, ~~according to patent claim 3,~~ the pilot valve arrangement has a pilot valve which is arranged between the first line segment and a relief line and the response pressure of which can be varied, for example, between two pressure stages. In particular, the pilot valve may be a pressure limiting valve with two pressure stages and with a valve element which is acted upon in the opening direction by the pressure occurring directly at

the valve inlet. It is also possible, however, that the valve element of a pilot valve arranged between the first line segment of the load indication line and a relief line or connectable between these is acted upon the opening direction by the pressure on that side of the nozzle which is remote from the regulating valve. The pilot valve will then limit the control pressure in that line segment between the nozzle and the regulating valve to which said pilot valve is connected with its main inlet separate from a control inlet to a pressure lying below the response pressure by the amount of the regulating Δp .

A first possibility for obtaining two pressure stages of the pilot valve is, ~~as specified in patent claim 4,~~ to vary the prestress of a valve spring which acts upon the moveable valve element of the pilot valve in the direction of the closing position counter to a pressure force generated at an active face of the valve element.

For this purpose, preferably, ~~according to patent claim 5,~~ an auxiliary piston is used, via which the prestressing force of the valve spring can be varied between two values defined by a first fixed abutment and a second fixed abutment. The auxiliary piston has an active face which is larger than the active face on the valve element, so that, when the two active faces on the valve element and on the auxiliary piston are acted upon with the same pressure, the auxiliary piston will initially prestress the valve spring to a greater extent, before, with the pressure rising further, the pilot valve opens, and then reliably maintains its position determined by the abutment defining the higher value of the spring prestress. The active face on the auxiliary piston can be relieved of pressure or can be acted upon with pressure as a function of the switching position of a reversing valve, said switching position being determined by the pressure in the further line segment of the load indication line.

By reversing valves being used, a very low pressure in the further line segment of the load indication line is sufficient to set the pilot at the low limit pressure.

It is especially advantageous if, ~~according to patent claim 6,~~ the two abutments can be adjusted independently of one another as a result of the rotation of two setscrews. Refinements of the hydraulic control arrangement ~~as claimed in patent claim 5 or 6 which~~ are advantageous particularly in structural terms ~~are found in patent claims 7 to 9.~~ It is in this case especially preferred, inter alia, that the valve spring can be supported at the end remote from the valve element by the auxiliary piston, that is to say this end can be displaced by the auxiliary piston. This seems simpler in structural terms than a basically also possible change in the spring prestress by means of a displacement of a valve seat for the valve element.

The response pressure of a valve, on the valve element of which a pressure force acts in the opening direction or, more generally, a pressure force acts in one direction and a spring force acts in the opposite direction, can not only be varied by a variation of the spring prestress, but also by a variation of the effective active face for the pressure occurring. ~~According to patent claim 10, the~~ The latter is achieved, in a pilot valve for the hydraulic control arrangement according to the invention, in a structurally simple way in that the valve element can be acted upon in the opening direction by a pressure occurring in the first line segment of the load indication line and at a first control face, and in that there is a second control face on an auxiliary piston which acts on the valve element and which can be relieved of pressure or can be acted upon with pressure as a function of the switching position of a reversing valve, said switching position being determined by the pressure in the further line segment of the load indication line. ~~Preferably, according to patent claim 11 or 12, the~~ The valve element is

acted upon in the closing position by a pressure occurring at the second control face, the second control face being smaller than the first control face.

The reversing valve may be a simple and cost-effective 2/2-way directional control valve with a single control edge when, ~~according to patent claim 13,~~ it is arranged in series with a nozzle between the load indication line and a relief line, the control space on the auxiliary piston lying at the connection between the nozzle and the 2/2-way directional control valve. ~~According to patent claim 14, however, the~~ The reversing valve may also be a 3/2-way directional control valve which connects a control space on the auxiliary piston to the load indication line in one switching position and to a relief line in the other switching position. There is no control-oil loss stream in any position of the reversing valve here, since the 3/2-way directional control valve separates the load indication line from the relief line in both switching positions.

Directly controlled valves which can be set during operation to response pressures differing in steps are seldom required, are special constructions and are therefore relatively costly to produce. Valves produced in large series can be used for the pilot valve arrangement if, ~~according to patent claim 15,~~ the latter has a first pilot valve arranged between the first line segment and a relief line or connectable between these and a second pilot valve arranged between the load indication line and the relief line or connectable between these, and the response pressure of the second pilot valve is lower than the response pressure of the first pilot valve.

~~A refinement according to patent claim 16~~ is especially preferred in this case, according to which the two pilot valves are pressure limiting valves and the second pilot valve can be connected with its inlet to the first line segment via a reversing valve switchable as a function of the pressure

occurring in a further line segment of the load indication line. Here, too, the reversing valve may be a small valve which is produced cost-effectively in large quantities.

~~In a construction according to the patent claim 17,~~ the following is achieved. Since the inlet of the second pilot valve constructed as a pressure limiting valve is connected with its inlet, downstream of a nozzle, to a first further line segment of the load indication line or to the associated individual load indication duct, when the associated function (directional control valve section) is operating in the solo mode the system pressure is limited by the response pressure of the second pilot valve. By contrast, when this function (directional control valve section) is operating in the parallel mode, with a function arranged further forward and set at a higher pressure (directional control valve section), the pump pressure can rise to the higher value, since a higher control pressure can be indicated to the regulating valve via the load-sensing branch of the front function. In the event of the actuation of the function (directional control valve section) which is assigned to a line segment following the first further line segment to the rear, the reversing valve is switched and the pressure in the first line segment of the load indication line is thereby limited to the low response pressure of the second pilot valve, so that the system pressure is also limited to the low value.

~~According to patent claim 18,~~ The second pilot valve is arranged between the first line segment and the relief line and its valve element can be acted upon in the closing direction by a valve spring and in the opening direction by the pressure occurring in the further line segment. No directional control valve is used here. In this construction, in the event of a parallel actuation of a plurality of hydraulic consumers, the system pressure can rise above the value induced by the response pressure of the second pilot valve, as long as the load pressure

of the hydraulic consumer protected with the lower pressure lies below the response pressure of the second pilot valve. Only when the load pressure rises to the response pressure of the second pilot valve does the latter limit the control pressure of the regulating valve to a value lying below the response pressure by the amount of the regulating Δp .

~~Patent claims 19 to 21 relate to the~~ The advantageous accommodation of the pilot valve arrangement in a directional control valve section with a single-acting function, in which the free space of the consumer connection not required is available. The reversing valve is advantageously arranged perpendicularly to the plane of the directional control valve disk, since the control line for the pressure signal for adjusting the pilot valve arrangement, said control line running perpendicularly to the disk planes, can issue into the reversing valve directly at the flange face of the single-acting directional control valve control section.

BRIEF DESCRIPTION OF THE DRAWINGS

Page 17, Line 5, before this line insert the following paragraph heading:

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT